1,057,456

# PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

## Multi-Colour Printing of Flexible Materials

We, COLODENSE LIMITED, a British Company, of West Street, Bedminster, Bristol 3, do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to the multi-colour printing of webs of flexible materials using the gravure printing method and, in particular, to the printing of webs which are unstable in that they stretch and/or shrink during printing and drying operations. Examples of such unstable webs are cellulose film and polyethylene film.

In the gravure printing method, a web of a flexible material is pressed by a resilient backing roller against a rotating engraved or etched cylinder, known as a gravure or intaglio cylinder, and is printed with a desired design by ink which has been supplied to the engraved or etched recesses. As the gravure cylinder rotates, ink is applied to the cylinder on each rotation by an inking means and excess is removed from the surface by a doctoring means before the cylinder makes contact with the web.

In a known method of multi-colour printing by the gravure method, the web is passed in a continuous manner through two or more spaced printing stations, each of which comprises a gravure cylinder with resilient backing roller and associated inking and doctoring means, when, at each station, a part of the desired design in a particular coloured ink is applied to the web. The spacing of the stations, the path taken by the web, the speed of the web and the drives to the cylinder at each of the stations are so correlated that each impression at each station lies in perfect register on the web to build up the required composite multi-colour design. To maintain perfect register, high web tensions and heavy impression loads are necessary. However, with unstable webs on which the necessary tension cannot be maintained, unpredictable stretching and/or shrinking of the web on passing through the stations, presents great difficulties in maintaining perfect registration of each of the impressions and it is necessary to maintain constant manual or electrical control to obtain acceptable registrations.

One proposal for overcoming the difficulties experienced with unstable webs is to pass the unstable web around a rubber-covered common impression cylinder where it is held firmly against movement during printing by two or more gravure cylinders in turn, stationed at spaced intervals around the periphery of the impression cylinder. A drying unit is placed immediately after each printing station to ensure that the freshly applied ink impression is dried before the next impression is made at the next printing station.

Such a multicolour machine, however, has the disadvantages that unless the impression cylinder is excessively large, there is little space between the printing stations, doctoring of the gravure cylinders is very difficult when the cylinders are positioned at certain upper stations around the periphery of the impression cylinder and if the rubber covering of the cylinder is damaged, repair or replacement is a difficult and expensive operation.

The object of the present invention is to provide an improved multi-colour gravure printing apparatus.

Accordingly, the present invention includes a multi-colour gravure printing apparatus for applying ink impressions to a travelling web of a flexible material comprising a continuous flexible inextensible belt caused, in one run, to follow an arc-shaped path for supporting the web on the convex surface of the belt, two or more positively driven gravure printing cylinders with associated inking and doctoring means placed at spaced intervals adjacent the belt as it describes the arc-shaped path for applying ink impressions in register to the web

[*Price 4s. 6d.*]

supported on the belt, a drying means stationed after each printing cylinder for drying the freshly applied impression, a driving means for driving the belt and urging means for urging the belt to follow the arc-shaped path so that the web supported on the belt is held in intimate non-slip contact with the belt.

It is an important feature of the invention that the belt when describing the arc-shaped path is always bowed in the same direction, that is, the sense of curvature of the path of the belt does not change between the first and last printing cylinder and over no part of the path follows a straight line so as to ensure that the web is always positively held against movement relative to the belt during the passage of the belt through the arc-shaped path.

The urging means for urging the belt to follow the arc-shaped path may consist of a smooth arc-shaped guide over which the belt is drawn.

In a preferred form of the invention, however, the belt is caused to describe in one run an arc-shaped path, by the application of a gaseous medium under pressure, conveniently air, to one side of the belt so that the belt, when passing through the printing zone is, in effect, riding over a gaseous cushion. The gaseous medium under pressure is conveniently applied from nozzles, for example from holes in air boxes, supplied with the gaseous medium air, under pressure.

Backing rollers, usually associated with gravure cylinders, may be stationed along the concave surface of the belt passing through the arc-shaped path so as to press the web supported on the belt against the associated inked gravure cylinders or to provide a firm backing for the web and belt pressed against the backing rollers by the gravure cylinders. When gaseous pressure is used to urge the belt to follow an arc-shaped path, it may be possible to dispense with the backing rollers.

In addition to the gravure, printing cylinders, one or more other types of printing cylinders, such as relief cylinders, may be placed at spaced intervals along the belt as it describes the arc-shaped path. This combination of gravure cylinders and other type printing cylinders has the advantage that the expensive gravure cylinders can be reserved solely for those impressions where high tonal quality is required.

The belt is conveniently a synthetic rubber impregnated fabric having a suitable tensioning means to ensure that the belt is tensioned to a desired degree when passing through the run which includes the arc-shaped path. The belt may also be a stainless steel or polyester band. Further, it is preferred that the arc-shaped path is so arranged that the belt bows downwardly when the inking means and doctoring means for the gravure cylinders can be placed in convenient, readily accessible positions with respect to the cylinders.

The belt with associated travelling web may be driven through the printing zone by the drive applied to the gravure cylinders. However, particularly when the driving load is high or no backing rollers are employed, it is more preferable to drive the belt with independent driving rollers at a speed equal to the peripheral speed at which the gravure cylinders are driven. The driving load is then removed from the gravure cylinders and more sensitive adjustment of the impression pressure to obtain good print quality is possible.

The drying means are conveniently hot air heaters which preferably are followed by air cooling means. Since the web is held rigidly in contact with the belt, high rate-of-flow heaters and coolers can be used, thus permitting the path length between printing cylinders to be at a minimum.

Whereas, the travelling web may be of any suitable printable material, the apparatus is particularly useful for the printing of unstable webs, that is webs which stretch or shrink during printing, for example cellulose film, polyethylene film, polypropylene film, vinylidene chloride copolymer film, rubber hydrochloride film or aluminium foil, since, while the web is held in intimate contact with the belt, any tendency to stretch or shrink is restrained. Thus, once the printing apparatus is set up, the separate impressions applied to the web passing with the belt through the arc-shaped path will remain substantially in register, thus dispensing with the necessity to maintain a constant watch and apply constant corrections.

Further, since the control of print register is independent of web tension, the impression pressure may be adjusted as required to obtain optimum print quality without affecting print register.

This invention also includes a method for applying multicolour ink impressions to a travelling web of a flexible material comprising supporting the web on a travelling continous flexible inextensible belt causing the belt to follow an arc-shaped path with the web on the convex surface of the belt so that the web is held in intimate non-slip contact with the belt, applying ink impressions in register to the web from two or more positively driven inked gravure printing cylinders at spaced intervals while the web is carried through the arc-shaped path by the belt and substantially drying each ink impression before applying a further ink impression.

Examples of multi-colour gravure printing apparatus constructed and adapted to operate in accordance with the invention will now be described with reference to the drawing accompanying the Provisional Specification (designated Figure 1) which is a diagrammatic front elevation partly in section and the drawing accompanying the present Specification (designated Figure 2) which is also a diagrammatic front elevation.

In Figure 1, a web 1, for example of polyethylene film which has been pretreated with an electric discharge to render it receptive to printing inks, is supported on a travelling continuous belt 2 and carried through four spaced gravure printing stations indicated generally at 3, 4, 5, 6, at each of which the web receives an ink impression. Each printing station 3, 4, 5, 6 consists of a rotably driven gravure cylinder 7 dipping in an ink bath 8, a doctor blade 9 to remove excess ink from the cylinder 7 which is urged towards a freely rotatable backing roller 10, which presses the belt 2 with the supported web 1 against the inked cylinder 7. Each gravure cylinder 7 applies an element of a desired design to the web 1 in a particular coloured ink and the cylinders 7 are so oriented and driven that each impression is applied in register with the preceding impression. To ensure that each impression is substantially dry before another impression is applied, hot air heaters 11 immediately followed by air coolers $11^1$ are placed after the cylinders 7 of stations 3, 4 and 5. An infra red heater 12 to dry completely the printed web 1 before it is wound into a storage roll (not shown) is placed adjacent the web 1 after it has left the last printing station 6.

The printing stations 3, 4, 5, 6 are so placed that the belt 2 with associated web 1 is caused to pass through an arc-shaped path which bows downwardly and, in order to maintain a continuous arc-shaped form in the belt between the stations 3, 4, 5 and 6, air boxes 13, 14 and 15 are placed on the concave side of the belt 2 between stations 3, 4 and 5 through which air under pressure is applied to the belt 2 and maintains the belt 2 in a bellowed out state. The air is introduced to the boxes 13, 14, 15 by pipes 16 and is directed upon the belt 2 through holes 17.

The belt 2 is maintained in a tensioned state by a tensioning device consisting of a fixed roller 18 and a slidable roller 19 (slidable in a slide 20) around which the belt 2 is caused to pass in an S-shaped configuration. The roller 19 is caused to pass in an S-shaped configuration. The roller 19 is urged to the right to maintain the tension in the belt 2. The belt 2 is driven by passage through the nip between the driven cylinders 7 and the rollers 10.

In Figure 2 the apparatus is similar to that shown in Figure 1, like parts being numbered alike, except that the belt 2 is positively driven by two driving rollers 21, 22 placed at each end of the arc-shaped run of the belt 2 at the peripheral speed of the driven cylinders 7. By this arrangement the driving load for driving the belt 2 is removed from the cylinders 7 which, however, are still positively driven to maintain accurate print register. Additional air boxes 23, 24 are placed between the driving rollers 21, 22 and the end backing rollers 10 to maintain the belt 2 in the shape of an arc between the driving rollers 21, 22.

Since the belt 2 is caused to follow an arc-shaped path on passing through the printing stations, the web is held firmly in contact with the belt 2 and any tendency for the web 1 to expand or contract is restrained and thus deviations likely to cause the impressions to fall out of register are avoided. Further, since the web 1 bows downwardly in the path through the printing stations 3, 4, 5, 6, the ink baths 8 and doctoring blades 9 can be conveniently placed with respect to the cylinders 7 and the cylinders 7 can be spaced at reasonable intervals to facilitate maintenance and operating attention.

WHAT WE CLAIM IS:—

1. A multi-colour gravure printing apparatus for applying ink impressions to a travelling web of a flexible material comprising a continuous flexible inextensible belt caused, in one run, to follow an arc-shaped path for supporting the web on the convex surface of the belt, two or more positively driven gravure printing cylinders with associated inking and doctoring means placed at spaced intervals adjacent the belt as it describes the arc-shaped path, for applying ink impressions in register to the web supported on the belt, a drying means stationed after each printing cylinder for drying the freshly applied impression, a driving means for driving the belt and urging means for urging the belt to follow the arc-shaped path so that the web supported on the belt is held in intimate non-slip contact with the belt.

2. A printing apparatus as claimed in claim 1 in which the urging means for urging the belt to follow an arc-shaped path is a gaseous medium under pressure.

3. A printing apparatus as claimed in claim 2 in which the gaseous medium is applied from nozzles supplied with the gaseous medium under pressure.

4. A printing apparatus as claimed in claim 1, claim 2 or claim 3 in which the belt bows downwardly when passing through the arc-shaped path.

5. A printing apparatus as claimed in any one of the preceding claims in which backing rollers associated with each gravure cylinder are stationed along the concave surface of the belt.

6. A printing apparatus as claimed in any one of the preceding claims in which the belt is driven by the positively driven gravure cylinders.

7. A printing apparatus as claimed in any one of the claims 1 to 5 in which the belt is driven by driving rollers placed at each end of the arc-shaped run of the belt and capable of driving the belt at the same speed as the peripheral speed of the driven gravure cylinders.

8. A printing apparatus as claimed in any one of the preceding claims in which one or more relief printing cylinders in addition to

the gravure printing cylinders, are placed at spaced intervals along the belt as the belt describes the arc-shaped path.

9. A printing apparatus as claimed in any one of the preceding claims in which the belt is a synthetic rubber impregnated fabric.

10. A printing apparatus as claimed in claim 1 substantially as described with reference to Figure 1 accompanying the Provisional Specification or Figure 2 accompanying the present specification.

11. A method for applying multi-colour ink impressions to a travelling web of a flexible material comprising supporting the web on a travelling continuous flexible inextensible belt causing the belt to follow an arc-shaped path with the web on the convex surface of the belt so that the web is held in intimate non-slip contact with the belt, applying ink impressions in register to the web from two or more positively driven inked gravure printing cylinders at spaced intervals while the web is carried through the arc-shaped path by the belt and substantially drying each ink impression before applying a further ink impression.

12. A method as claimed in claim 11 in which the belt is caused to follow an arc-shaped path by gaseous pressure applied to the belt.

13. A method as claimed in claim 11 or claim 12 in which the web is cellulose film, polyethylene film, polypropylene film, vinylidene chloride copolymer film, rubber hydrochloride film, or aluminium foil.

14. A method as claimed in claim 11 substantially as described, with reference to the apparatus illustrated in Figure 1 accompanying the Provisional Specification or Figure 2 accompanying the present Specification.

15. A printed web when printed by a method as claimed in any one of the claims 11 to 14.

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1 SHEET

PROVISIONAL SPECIFICATION

*This drawing is a reproduction of the Original on a reduced scale*

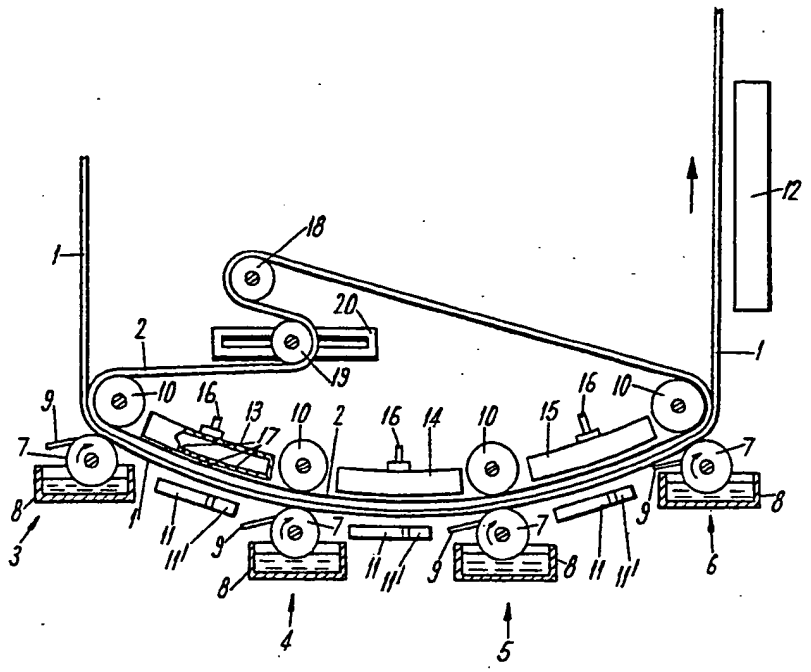


FIG. 1

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1 SHEET This drawing is a reproduction of the Original on a reduced scale

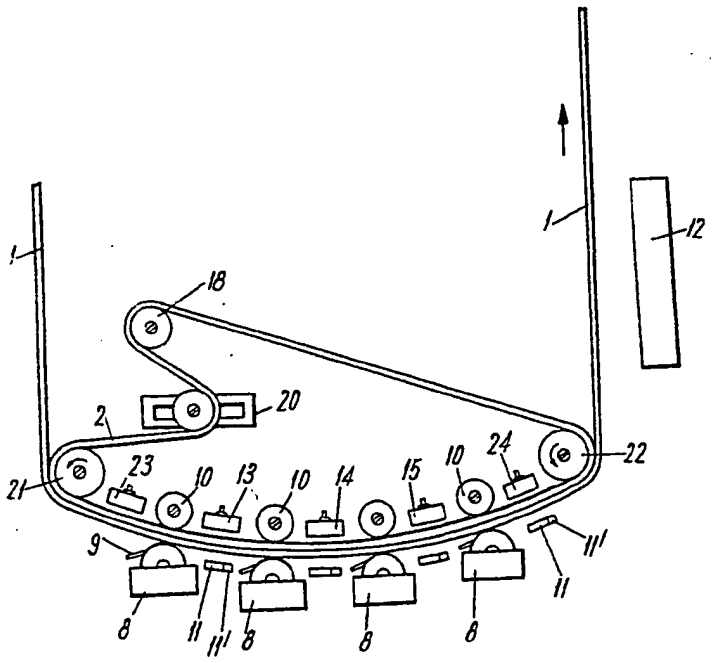


FIG. 2